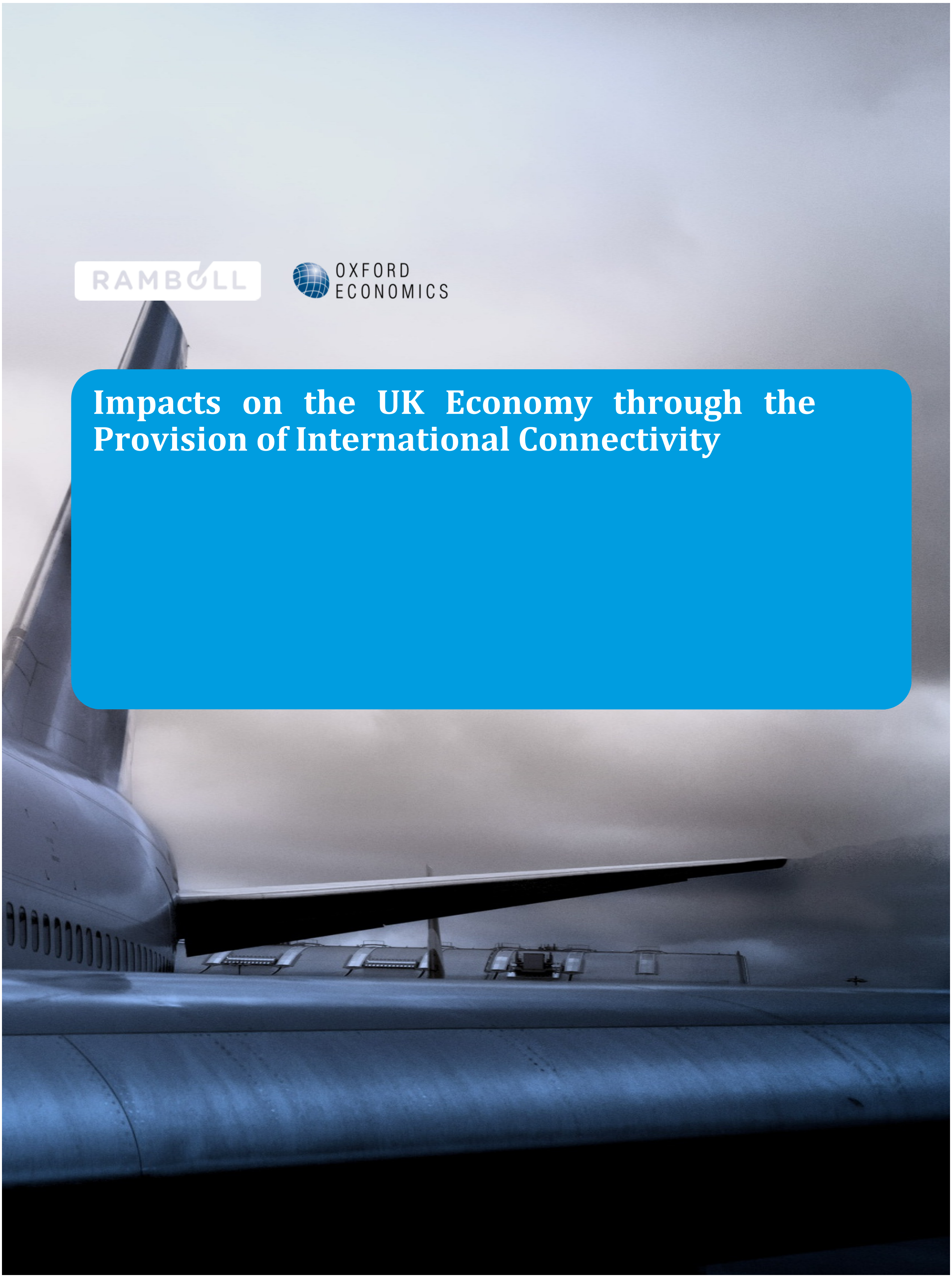


Impacts on the UK Economy through the Provision of International Connectivity

Contents

Executive Summary

- Trade has always been central to the UK's prosperity. We are connected to the global economy in numerous ways – through the trade in goods and services, through cross-border investment, and through the movement of people and ideas. While it has always been recognised that air transport is crucial to these international linkages, until recently there has been few attempts to quantify the value of air transport connectivity to the UK economy.

- Building on previous research by Oxford Economics, this paper explains how the value of connectivity can be measured by using an econometric model. We use the model to evaluate the connectivity benefits likely to be generated through building a new hub airport in the South East. It is part of a series of technical notes by Oxford Economics and Ramboll, prepared for Transport for London in support of Lot 4 of the Mayor's Aviation Work Programme – the assessment of socio-economic effects. The Aviation Work Programme, in turn, has been conducted in order to develop a submission to the Airports Commission (or "Davies Commission") which has been charged with examining the need for additional UK airport capacity.

- The notes prepared by Oxford Economics have been designed to address specific questions and issues posed within paragraph 3.16 of Aviation Commission (2013) *Guidance Document 01*. While the notes prepared by Oxford Economics are separate, there is nonetheless some degree of interaction between the issues they examine. The issues and results from some of the key technical notes prepared by Oxford Economics are summarised in the table below:

Table 1: Summary of key Oxford Economics Technical Notes

Davies Commission Question/Issue	Results/Key messages
Impacts on the UK economy through the provision of international connectivity - Alignment with the likely growth in demand for travel and ability to service that demand.	■ This note used an econometric model to examine connectivity benefits likely to be generated through building a new hub airport in the South East. ■ The model suggests that a 10 per cent increase in business related connectivity increases economy-wide productivity – and hence GDP - by 0.5 per cent in the long-run. ■ The long-term economic benefit of expanding airport capacity in the London area, consistent with the Department for Transport's "unconstrained" capacity forecasts for 2050, is found to be equivalent to a GDP boost of £6.9 billion a year (at today's prices).
Impacts on the local economy	■ This note examined the employment and Gross Value Added (GVA) impacts of

through the direct effects of airports - Impacts on the local and national economy through both direct and indirect effects on employment and skills.	construction and operation of a new hub airport at Stansted, the Isle of Grain or the Outer Estuary. ■ On a *gross national* basis, the total economic impacts of operating a new airport and associated ground transport at Stansted, the Isle of Grain or the Outer Estuary in 2050 vary from 377,000-392,000 jobs (depending on the option chosen) and £42bn of GVA ■ On a *net local* basis, the operation of a new hub airport at Stansted, the Isle of Grain or the Outer Estuary means employment in the local area is 123,000-134,000 higher and GVA is £16.2-£16.6 billion higher than would otherwise have been the case in 2050.
Impacts on the local economy through the direct effects of airports - Impacts on other airports.	■ This note modelled the economic impacts of the closure of Heathrow in the event of a new hub airport being developed. ■ Excluding local redevelopment impacts, Heathrow local area employment would be 77,000 lower in 2050 (compared to a business as usual baseline) if the airport were to close though unemployment is only modestly higher (3.5% rather than 3.0%). ■ If the effects of a subsequent residential redevelopment scenario of the old Heathrow site are allowed for, in addition to the impacts of closure, then local area employment would be 33,500 lower compared to the baseline, while unemployment would stand at 3.6%. ■ Local area employment falls should not be confused with increases in unemployment. A local area resident who is subsequently re-employed outside the local area (e.g. at the new hub or elsewhere) would be a “job loss” *from the point of view of the local area* but would not be unemployed. ■ Regardless of closure, local population, employment and housing stock all increase between 2029 and 2050. This is even more true for the closure plus redevelopment scenario, where local population is 136,000 *higher* than the baseline population.
Consumer impacts - Impacts on the air freight industry, its customers and	• This note examined how increased airport capacity (or conversely the lack of additional new capacity) could affect airfreight and the economy. • Capacity constraints at Heathrow may have set in as early as 2005 and future cargo

associated business sectors	growth is threatened by the inability of London area airports to keep up with demand. • Modelling using the central case of a range of forecast scenarios suggests that by 2050, the value of air cargo lost to London due to capacity constraints would equate to £106 billion per annum. However, this is not equal to a net national GDP loss as much of this freight may be traded via other UK airports, or enter the UK indirectly. • An alternative, economic welfare based approach, suggests that by 2050 *net national* losses due to airfreight capacity constraints could equate to £3.9 billion per annum.

- Based on an econometric model, we estimate that a 10 per cent increase in business related connectivity increases economy-wide productivity – and hence GDP - by 0.5 per cent in the long-run, equivalent to £6.9 billion at today's prices.
- Key features of the model include –
    - Business-related connectivity is measured using Oxford Economics' business connectivity metric, described in Section 2. The measure, which covers both business-related travel and freight, is designed to focus on the linkage between the provision of air transport services and long-run productivity growth.
    - The economic benefits are measured in terms of Total Factor Productivity (TFP). These benefits include the dynamic gains generated by the quick adoption of new ideas –such as inventions and new business methods – and from the ready access to new and fast growing overseas markets.
    - The model analyses the link between TFP performance and the use of air transport services among in 30 industry and service sectors.
    - The analysis examines the link between air connectivity and TFP performance over the past three decades.
- The note places our modelling within the wider economic literature on quantifying the economic benefits generated from major infrastructure projects. We also compare our results with similar past research, including studies conducted by Oxford Economics (OE) which our current work builds on.

- Finally, the note provides a thorough description of the available measures of connectivity that have been used in this field of research.

1 Introduction

1.1 The likely economic benefits of new hub airport capacity

This note provides an assessment the long-term benefits to the UK economy that can be expected arise from the proposed expansion in airport capacity. It is one of a number of technical notes prepared as part of TFL 90001 Aviation Works Programme, Lot 4 Assessment of Socio-Economic Effects.

This note provides a model-based evaluation of the likely economic benefits which a major expansion of airport capacity will bring to the UK economy, by allowing airlines to extend and better configure their route networks. The perspective is long-term (out to 2050). Given its long-term perspective the modelling focuses on how improved air transport infrastructure enhances the structural "supply-side" performance of the economy. These supply-side benefits cover many of the "wider economic benefits" which are often overlooked (or at least not quantified) in traditional investment appraisals of transport projects. In the model these long-term supply-side benefits are quantified in terms of Total Factor Productivity, a measure of economic efficiency that takes account of both labour and capital resources employed, and which most economists believe is a key driver of countries' relative economic success.

The modelling approach adopted in this note complements the material presented in the other technical notes. The modelling draws on the freight forecasts presented in the relevant technical note dealing with impacts on the air freight industry. The model quantifies the importance of air transport connectivity to the performance of the economy. It is often difficult to bring in all the dimensions of a complex concept such as connectivity into a formal quantitative model. Recognising this, connectivity is examined in detail in a separate paper, *The Economic Value of International Connectivity* and a separate technical note dealing with regional connectivity. The modelling of long-term benefits described in this note complements the analysis of short-term demand-side employment and output benefits set out in the technical note dealing with economic impacts on the local and national economies.

1.2 Note Structure

The remainder of the note is structured as follows:

- **Section 2** discusses demand, supply and how air transport fosters economic growth.
- **Section 3** discusses modelling work to estimate growth impacts.
- **Section 4** concludes.

2 Demand, Supply and the Aviation Market

This section discusses the growth in air transport services over the past few decades, measures of connectivity, aviation capacity constraints in the UK and the importance of air transport services in fostering UK trade and growth.

Key Points

- In measuring connectivity, this note will focus on passengers whose primary purpose of travel is business and on cargo to measure the effect of business us of air services in GDP
- DfT aviation forecasts mean that by 2020, capacity will be already lacking for 5 mppa. By 2050, this gap between supply and demand will increase to 35 mppa. In terms of runway capacity, all London airports will be at 100% utilisation by 2030 in the central forecast.
- Eddington(2006) cites that UK international aviation gateways have some of the greatest delays in the EU. 28% of Heathrow flights and 24% of Gatwick flights are delayed for more than 15 minutes. As the margin of spare capacity is eroded, the delays will only get more severe.
- Due to the greater capacity on offer at a new hub airport, more destinations would be served than are currently being served at Heathrow, thus increasing connectivity. By 2050, a new four-runway hub would serve 130 more destinations and would have nearly double the flight frequencies than Heathrow would (without new runways or terminals).
- The main pathway which aviation contributes to economic growth is by raising total factor productivity[1]; a measure of an economy's long-term technological change that is due to more efficient use of labour and capital inputs. This contribution occurs through aviation's input to business efficiency.
- There are positive externalities that do not feature in cost benefit analysis, which can lead to under-investment in infrastructure. Modelling TFP gains from infrastructure is a way to quantify these externalities.

2.1 Growth in Air Transport Services since 1961

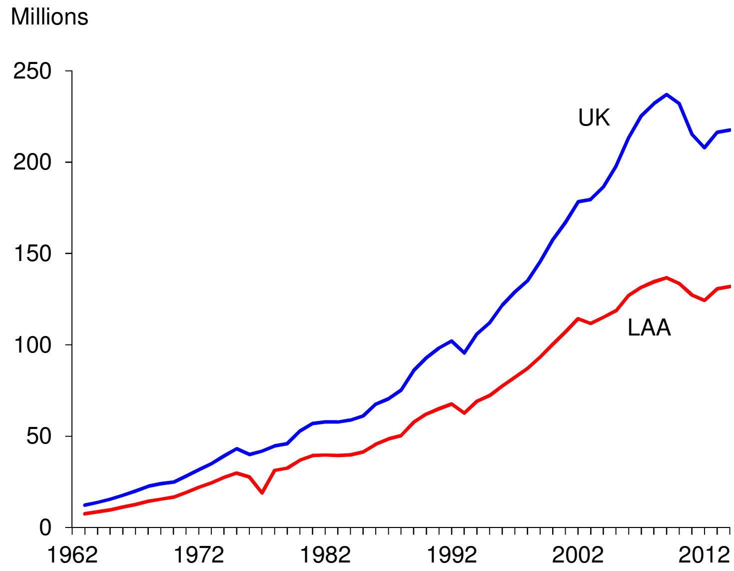
2.1.1 Passenger Traffic

The UK's passenger traffic has steadily increased since 1961[2]. Chart 2.1 below shows the trend for the UK and London area airports.

[1] Also known as the Solow residual

[2] Data from CAA is only available from 1961.

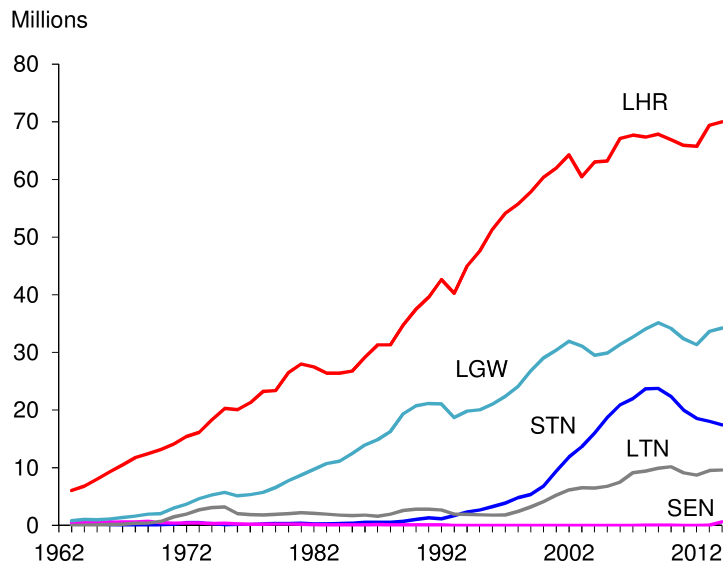
Chart 2.1: Passengers Traveling Through UK and London Airports – 1961-2012



Source : Oxford Economics

Increasingly, however, many more passengers are flying through airports outside of London. On average, passengers flying through UK airports during this period grew by 5.95%. Throughout the same period, passengers flying through London grew by 6.36%. By the 1990s, however, passenger growth in London slowed down, with growth from 1990-2012 at 3.22% compared to a UK-wide average of 3.62%. In terms of London area airports, chart 2.2 below shows passenger throughput per airport.

Chart 2.2: Passengers Traveling Through London Area Airports – 1961-2012



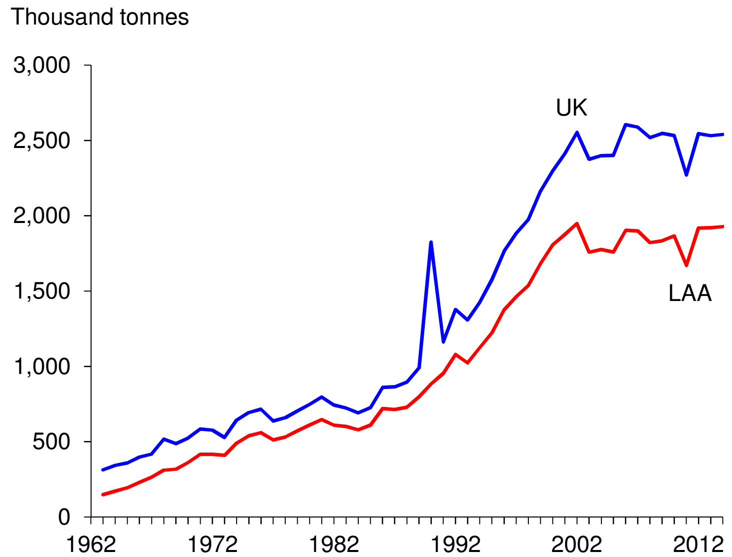
Source : Oxford Economics

Heathrow flies the majority of passengers, but other London area airports are now starting to pick up significant shares of passengers. For instance, Gatwick flew about half as many passengers as Heathrow. Meanwhile, passenger growth at Heathrow noticeably began to decrease after 2001.

2.1.2 Cargo Traffic

Cargo traffic (freight and mail) grew steadily for the UK and London area airports until 2000, when aviation fuel prices shot up. Chart 2.3 below shows this trend.

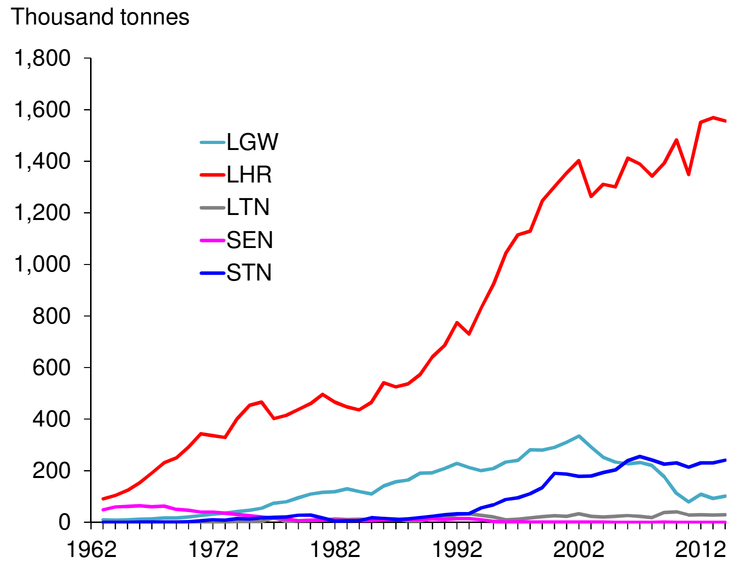
Chart 2.3: Cargo Traffic through UK and London Area Airports – 1961-2012



Source : Oxford Economics

Analysis of cargo throughput by London area airport demonstrates that the vast majority of cargo flies through Heathrow, London's only hub airport. Chart 2.4 shows this trend.

Chart 2.4: Cargo Traffic by London Area Airport – 1961- 2012



Source : Oxford Economics

Most of the cargo flown through London is belly hold cargo, carried on passenger airplanes. Further detail on patterns and trends in cargo traffic can be found in the technical note dealing with air freight issues.

2.2 Measuring Connectivity

2.2.1 Definition and Measurement of Connectivity

The definition of connectivity is relatively amorphous, as connectivity means different things to different people. It relates to a wide range of factors, including:

- Whether the desired destination is served from a convenient airport or whether an indirect routing is required or potentially whether any routing at all is available. This links clearly to an airport's – or airports' – ability to deliver breadth in network connections;
- The time it takes to travel to the airport, transit through that airport, fly to the destination and transit at the other end;
- The frequency of service, which links to whether connections are likely to be convenient to passengers' desired travel patterns and to flexibility in requirements and resilience;
- The quality of service both in terms of the choice of products on offer and in terms of the overall experience of travel;
- The reliability and resilience of services, which links to user considerations around waiting times and ultimately choice of destination;
- The costs of travel both in relation to surface access to the airport and in relation to air fares.

This note will focus on what might be termed economically advantageous connectivity – air services that support economic prosperity. In measuring connectivity, this note will focus on passengers whose primary purpose of travel is business and on cargo to measure the effect of business use of air services on GDP.

2.2.2 Prior Work by Oxford Economics on Connectivity

The value of air transport to a business clearly depends on air services being available that allow either passengers or freight to travel between the desired origin and destination for a trip. The ease with which this can be done will depend both on the range of destinations served by air services that can be accessed, and on their frequency. In other words, it depends on how well connected a location is with other parts of the world by air services.

Oxford Economics published two prior reports on the economic contribution of the aviation industry in the UK, one in 1999 and another in 2006. These reports both feature econometric analysis of the impact of economically advantageous connectivity on GDP, which is called the elasticity of output with respect to aviation. The main pathway in which this GDP growth occurs is via more efficient business operations, which boost total factor productivity (TFP), in turn boosting GDP.

First, a measure of air transport services that is closely aligned to business use of aviation was constructed by combining the number of business passengers at UK airports with the volume of air freight. Regression equations were then constructed to assess the relationship between this measure of air transport services and TFP using a panel of data for different UK industries over time. In the end, TFP in each industry is linked to an industry constant, an industry time trend, and business air use relative to GDP, weighted by the importance of air services in the industry's costs.

Box: Air transport as a catalyst to productivity growth

Air transport supports the economy through multiple channels, such as by facilitating trade, inward investment, expanding export markets, and boosting tourism. In particular, by encouraging investment and the flow of new ideas, the aviation sector can generate powerful spillover benefits to the wider economy. Investment plays a key role in keeping UK industry at the technological frontier, because cutting edge technology is usually embedded within new capital equipment. Highly skilled professionals from all over the world come to work in the UK and London in particular, attracted by its good air connections and cosmopolitan character. Many sectors – such as finance, business services, industry and universities – benefit enormously from their skills and know-how. This flow of talented people is crucial in enabling UK businesses to remain at the frontier of technology and best business practice.

While hugely important, quantifying the economic benefits that these aviation-related spillovers bring to the UK economy is challenging. This isn't surprising given the time it takes for new technologies and knowledge to 'bed down'. In the long-term, however, spillovers appear as gains in **total factor productivity (TFP).** TFP are efficiency gains measured against the most demanding yardstick – one's ability to increase the quantity and quality of output without using more resources, whether the resources are people or equipment. As such, TFP is a key driver of higher living standards and increase competitiveness on international markets. As a catalyst for raising TFP across economy, the aviation sector punches above its weight in its contribution the UK economy's long-term performance.

In Section 3, we explain how we quantify the link between businesses' use of air transport and the TFP performance of the wider economy. To this end we need good estimates of TFP at a detailed industry/sector level is very important for this task. We draw on the latest research in TFP measurement, EUKLEMS, a government/academic research database that measures TFP for over 30 UK sectors, based on a forensic analysis of capital (K), labour (L), energy (E), and materials (M) and services (S) inputs used in production.[3] Using this data we find clear evidence that the aviation sector does indeed generate TFP spillovers for the UK economy.

2.2.3 IATA Connectivity Work

IATA, in their work "Airline Network Benefits: Measuring the Additional Benefits Generated by Airline Networks for Economic Development", used a connectivity index based on destinations served and frequencies of service for different airports around the world to measure the statistical link between connectivity and long-run investment and productivity for EU countries. Specifically, connectivity was measured as the number and economic importance of destinations served, the frequency of service to each destination and the number of onward connections available from each destination. This connectivity index was constructed using data from the OAG airline schedule database in the first week of November from 1997-2004. The formula used to calculate the connectivity indicator is described below:

[3] Full documentation and data on EUKLEMS is available online at http://www.euklems.net/ .

$$\frac{\textit{Number of destinations x Frequency x Seats per flight weighted by size of destination airport}}{\textit{Scalar factor of 1000}}$$

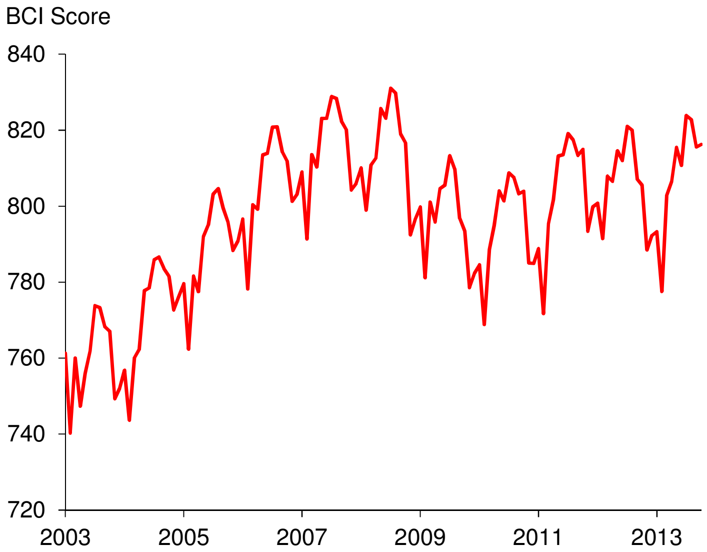
A larger connectivity number means a greater degree of access to the global air transport network. This measure of connectivity was then used in econometric work to determine the relationship between long-run investment and productivity for EU countries between 1996 and 2004, using an ordinary least squares estimator. The conclusion from this analysis was that a 10% increase in connectivity is thought to increase long-run GDP by 1.1%.

Afterwards, IATA published "Aviation Economic Benefits: Measuring the Economic Rate of Return on Investment in the Aviation Industry", which took the previous work further to link connectivity and productivity across a range of 48 countries, using data from 1996 to 2005. The regression model developed for this report controlled for factors such as education levels, research and development, capital spending, institutional and regulatory factors. Finally, a 1% increase in productivity was thought to increase long-run GDP by 1% for the sample of 48 countries.

2.2.4 York Aviation Connectivity Work

York Aviation has developed the business connectivity index (BCI). The BCI directly focuses on the relative value that different airports can offer to businesses in reaching economically desirable destinations. In turn, this measures the extent to which airports can support the economic benefits associated with connectivity. The BCI assesses the connectivity value of an airport based on the destinations served, an assessment of the economic importance of the destination city based on research by the Globalisation and World Cities network, and the level of frequency offered to those destinations. Therefore, the index produces a relative assessment of a city or country's business connectivity. Chart 2.5 below displays the UK's Business Connectivity Index throughout the past decade.

Chart 2.5: Business Connectivity Index for the UK in the Past Decade



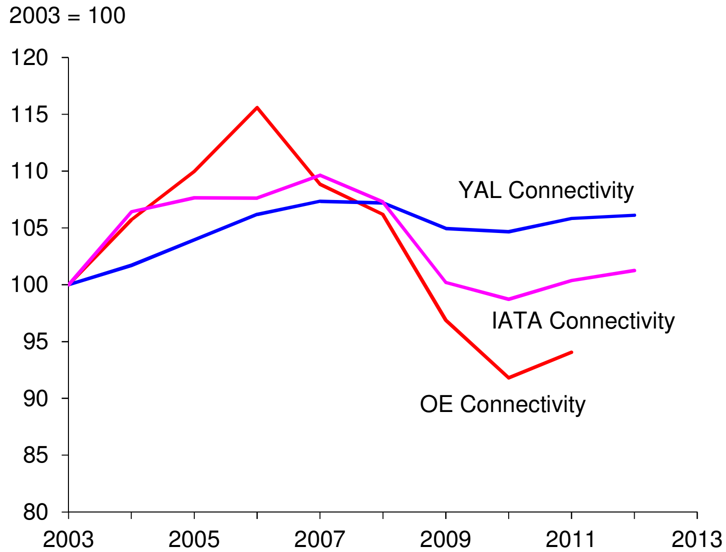
Source : York Aviation

The UK index is produced by aggregating data from all UK airports. Over this time frame, the UK's business connectivity, as measured by the index, has improved by approximately 7%.

2.2.5 Comparison Across Connectivity Measures

Comparing the Oxford Economics, IATA and York Aviation (YAL) connectivity measures shows that the IATA series and the Oxford Economics series are the most closely-related, with both the IATA and the Oxford Economics connectivity measures dipping after the 2008 recession. Chart 2.6 below shows this comparison using indexed values.

Chart 2.6: Comparison of Oxford Economics, YAL and IATA Connectivity Measures

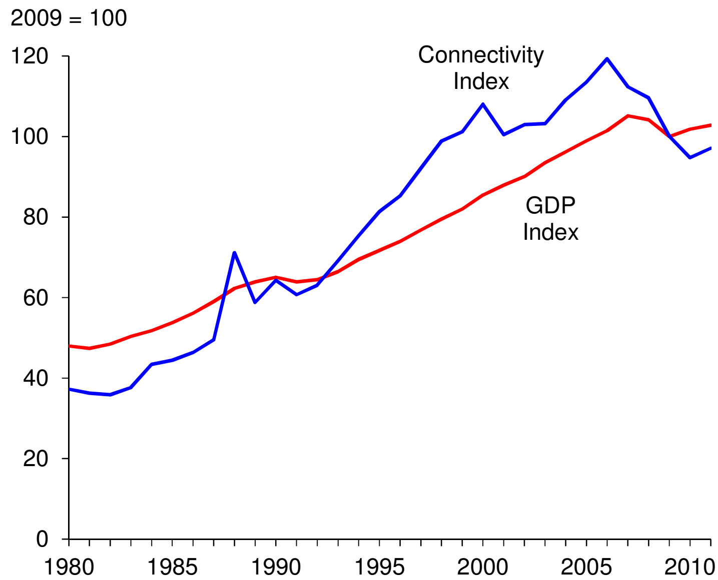


Source : Oxford Economics, IATA, York Aviation

In fact, a calculation of the correlation coefficient between the Oxford Economics and the IATA series shows that the two have a correlation coefficient of 0.91 (1.0 is perfect correlation). An important reason for not using the IATA connectivity measure in the econometric analysis detailed in section 3, however, is that the series only goes back to 2000, whereas the Oxford Economics series goes back to 1980.

Now, taking the Oxford Economics connectivity measure and comparing it to UK GDP shows that the two measures are highly correlated, with a 0.95 correlation coefficient. Chart 2.7 below shows this pattern.

Chart 2.7: Oxford Economics Connectivity and UK GDP



Source : Oxford Economics

The fact that the two series are highly correlated means that both series generally move in the same direction. This implies that connectivity growth has a positive relationship with GDP growth. The chart also implies that connectivity grows faster than GDP during periods of economic expansion and that it grows more slowly than GDP during periods of economic contraction.

2.3 Aviation Capacity Constraints

Recent reports have argued that London will face increasing capacity constraints unless more airport development takes place.

2.3.6 Comparison of DfT Constrained and Unconstrained Forecasts

The Department for Transport's latest aviation forecasts cover passenger numbers and air transport movements at UK airports. The Dft predicts that the demand for air travel will increase from 1-3% a year up to 2050. This is lower than historical growth rates of 5% a year over the past 40 years due to the expectation that the different passenger markets will reach maturity and the expectation that the decline in average fares experienced over the past 20 years will end.

Table 2.1 below summarises the central constrained and unconstrained passenger forecasts for all UK airports[4].

UK Terminal Passengers	Actual (mppa) 2010	Forecast (mppa) 2020	2030	2040	2050
Constrained Scenario	211	255	315	370	445
Unconstrained Scenario	211	260	320	390	480

Source: Department for Transport, 2013.

[4] mppa = million passengers per annum.

These forecasts mean that by 2020, capacity will be already lacking for 5 mppa. By 2050, this gap between supply and demand will increase to 35 mppa. In terms of runway capacity, all London airports will be at 100% utilisation by 2030 in the central forecast.

Spare capacity is critically important for infrastructure security of supply and its stability. This is because infrastructure projects are capital intensive and have long horizons. Due to these attributes, infrastructure projects must operate with spare capacity in order to contribute to future economic growth. Eddington (2006) cites that UK international aviation gateways have some of the greatest delays in the EU. 28% of Heathrow flights and 24% of Gatwick flights are delayed for more than 15 minutes. As the margin of spare capacity is eroded, the delays will only get more severe and the number of destinations available via direct flights will be constrained relative to other European hubs.

2.3.7 Capacity of Proposed Hub Options

The three proposed hub options at Stansted, the Inner Estuary and the Outer Estuary are all designed to meet the DfT's unconstrained demand as identified for Heathrow, the UK's principle hub. All three options would offer similar capacity. In its opening year, 2029, the new hub airport will accommodate 90 mppa. In that same year, Heathrow (with no new runways and terminals) is predicted to accommodate 82 mppa. Although the capacity of the new hub would be larger than Heathrow's from opening day, it will not be able to meet the DfT's unconstrained demand forecasts until five years after opening, in 2034, when it will accommodate 119 mppa. From that point on, the new hub will keep pace with unconstrained demand through 2050. Each proposed hub option would have 4 runways, except for Stansted, which will keep its existing runway for low cost carrier flights and have 4 new runways for its hub operation. Due to this, capacity at Stansted would be greater than capacity at the Inner or Outer Estuary. Table 2.2 below summarises the capacity offered by the three hub designs.

Table 2.2: Capacity Offered by Three Hub Options

		Airport Capacity		Airport Demand	
		Capacity of new hub in Estuary (mppa)	Capacity of Stansted airport (mppa)	Passengers at new hub in Estuary (mppa)	Passengers at Stansted hub(mppa)
2029 (opening)	Runways and taxiways	180	206	**90**	**110**
	Terminals and transport facilities	120	155		
	Satellites and gates	90	125		
2034 (meets DfT unconstrained demand for the first time)	Runways and taxiways	180	207	**119**	**145**
	Terminals and transport facilities	150	185		
	Satellites and gates	134	169		
2050	Runways and taxiways	180	209	**170**	**208**
	Terminals and transport facilities	180	215		
	Satellites and gates	180	215		
Source: Atkins.					

2.3.8 Enhanced Connectivity Due to Proposed Hub Options

Due to the greater capacity on offer at a new hub airport, more destinations would be served than are currently being served at Heathrow, thus increasing connectivity. By 2050, a new four-runway hub would serve 159 more destinations and would more than double the flight frequencies than Heathrow would (without new runways or terminals). This proposed new hub is projected to serve a total of 299 destinations with 9,226 flight frequencies. In fact, the connectivity offered by a new hub airport would be far greater than that offered by a 3x2 distributed hub solution (2 runways for each of the three main London airports). The 3x2 distributed hub would only offer as many destinations and frequencies as Heathrow would with 2 runways.

This is because a hub airport, due to the volume of transfer passengers, makes many more routes economically viable. For example, over 30% of Heathrow passengers are transfer passengers, as opposed to less than 10% at Gatwick and fewer at other London area airports[5]. A distributed hub would not offer fast enough transfers to allow these airports to serve as many transfer passengers. In general, the world's largest airports are hub airports, due to the airline industry's hub-and-spoke model. A separate technical note contains further details on the origin-destination pattern of the new proposed hub airport.

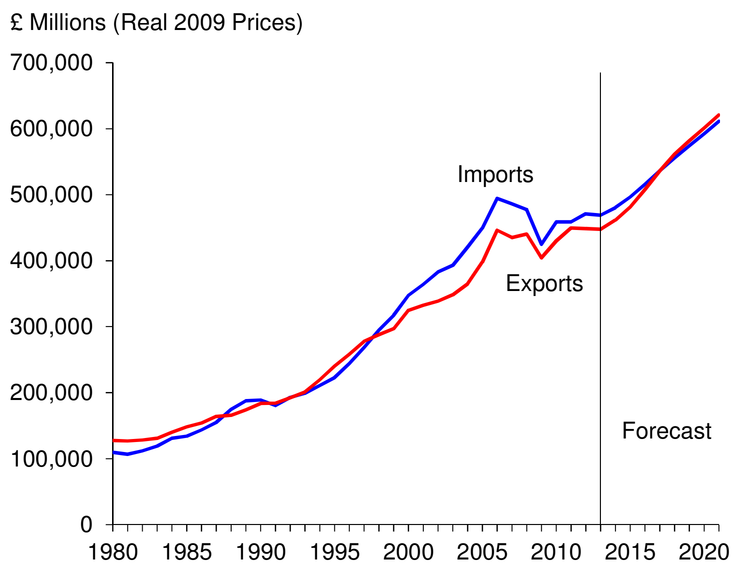
The additional destinations served and additional flight frequencies served would have direct impacts on trade, tourism and growth.

2.4 Importance of Growth in Air Transport Services in Fostering UK Trade and Growth

2.4.1 How Air Transport Services Support Trade, Tourism and Growth

International trade allows countries to specialise in goods and services in which they have a comparative advantage and to exchange them for goods and services wanted by consumers or producers that can be produced relatively more efficiently elsewhere. Chart 2.6 below shows the trend and forecast for UK trade.

Chart 2.6: UK Trade in Goods and Services 1980 – 2021



Source : Oxford Economics

Over the 1980 to 2012 period, the UK has experienced nearly 300% growth in overall trade (exports plus imports). Moreover, Oxford Economics predicts UK trade to grow an additional 34% from 2012 through 2021. Oxford Economics' global forecasts suggest that the global economy will become even more dependent on trade over the next decade, with world trade increasing by over 90% through 2021. International trade is a key driver of global economic growth and rising living

[5] UK Parliament Research Briefings, "UK aviation airports and capacity," Research Paper 12/59.

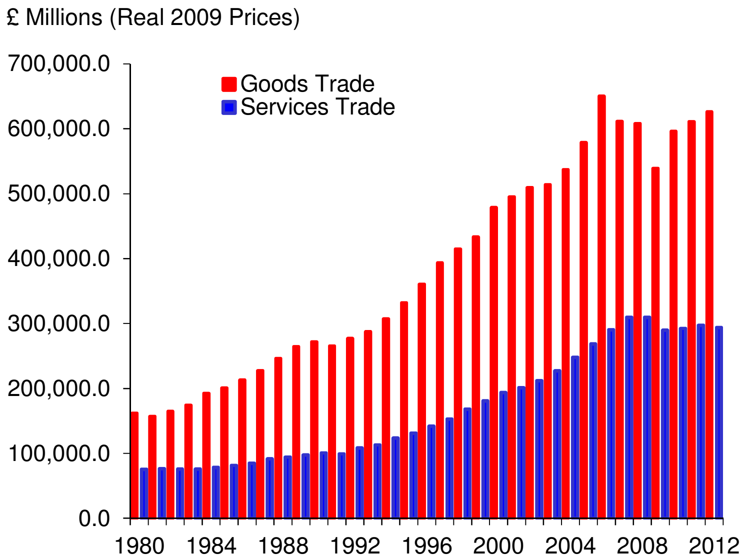
standards. Over the last 45 years, the countries that have grown the fastest have typically been those that have also seen the fastest growth in international trade.

Aviation facilitates not only trade in goods (via air cargo transport), but also trade in services (via air passenger transport). Passenger services are important to businesses, which rely on air transport as a means to reach suppliers, customers, and subsidiary entities in other countries. In a previous Oxford Economics survey conducted in 2006[6], nearly two-thirds of companies surveyed reported that passenger services were either vital or very important for sales and marketing, and a similar proportion reported that passenger services were either vital or very important for servicing or meeting customers. In addition, more than half of companies surveyed reported that the availability of frequent air services to/from the UK allowed them to sell to a wider market.

Research conducted on the United States by Oxford Economics in 2009[7] found that for every dollar invested in business travel, companies realize $12.50 in incremental revenue and $3.80 in profits. Executives and business travellers surveyed estimated that about 40% of their prospective customers become customers after an in-person meeting, compared to 16% without an in-person meeting. Furthermore, prior global modelling work completed by Oxford Economics indicated that one additional dollar invested in international business travel would, on average, generate $17 in worldwide trade and that a 10% increase in international business travel would increase world trade on average by 3%[8].

Chart 2.7 shows the split between trade in goods and trade in services for the UK.

Chart 2.7: UK Trade in Goods and Services 1980 – 2012



Source : Oxford Economics

While trade in services makes up a lower portion of total trade, it still represents a significant proportion of total trade and an even more significant proportion of total exports. In 2012, service

[6] Refer to Oxford Economic Forecasting's "The Economic Contribution of the Aviation Industry in the UK", produced in 2006.

[7] Oxford Economics, "The Return on Investment of US Business Travel," September 2009.

[8] World Travel and Tourism Council, "Business Travel: A Catalyst for Economic Performance."

exports made up two-thirds of total exports. This means that passenger air transport is exceedingly important for UK exports.

Some goods are traded by air, and these goods represented 35% of the value of the UK's non-EU trade in 2012, a value of approximately £120 billion. For the goods trade, air transport is also vital, whether it is dedicated freight transport or freight flown bellyhold on passenger planes. Further details on the UK's goods traded by air can be found in the technical note dealing with air freight issues.

Tourism is a key sector for the United Kingdom. The World Travel and Tourism Council estimated that the tourism industry contributed £106.3 billion in 2012 (6.8% of GDP). The United Kingdom is ranked 8th out of 184 countries in terms of the absolute GDP contribution of tourism. The aviation industry has a major role in supporting the UK's tourism sector. In 2012, 73% of visitors to the UK from abroad travelled by air and 84% of international visitor expenditure in the UK comes from tourists traveling by air[9]. In terms of visitors leaving the UK to travel abroad, 79% of them travelled by air, and this group represented 85% of total expenditure.

2.4.2 How Aviation Raises Total Factor Productivity

Yet another ingredient needed to increase economic growth is productivity growth, which is central to the achievement of sustainable economic growth. The main pathway by which aviation contributes to economic growth is by raising total factor productivity[10]; a measure of an economy's long-term technological change that is due to more efficient use of labour and capital inputs. This contribution occurs through aviation's input to business efficiency.

The role of aviation in international trade enhances the ability of companies to serve global markets and it helps these companies improve the efficiency of production by allowing them to build better relationships with their supply chain. There are efficiency improvements in management by making it easier for managers to visit subsidiaries or parent companies in another country. In fact, in a 2006 Oxford Economics survey, 70% of companies reported that passenger services are vital or very important for management[11]. The ability to better serve global markets spurs innovation in companies. In the survey, 40% of businesses stated that air transport services had a significant impact on the ability to innovate via the potential to serve a bigger market. In addition, companies reported increasing effects on sales and profits, more scope to exploit economies of scale and increased competition.

2.4.3 Literature on Infrastructure Spending and Economic Growth

Econometric studies of the productivity impact of infrastructure are but one of the ways in which infrastructure gaps can be identified. Other means are:

- Engineering needs assessments
- Political voting outcomes
- Calculation of economic rates of return to infrastructure spending (cost benefit analysis)

[9] Data from ONS Travel Trends 2012, Table 4.01.

[10] Also known as the Solow residual.

[11] Oxford Economic Forecasting, "The Economic Contribution of the Aviation Industry in the UK", produced in 2006.

There are positive externalities (see examples in the previous section), that do not feature in cost benefit analysis, which can lead to under-investment in infrastructure. Upstream infrastructure externalities at one specific node in the transport network are internalised by the market. The increase of capacity at one point in the transport network, however, has effects throughout the entire network. Hulten (2005) writes that “these indirect [effects] can lead to an overall increase in productive efficiency as, for example, when lower transport costs lead to an expansion in the size of product and input markets, in turn leading to efficiency gains through economies of scale and scope, increased competition, and to greater input specialization.” This can lead firms to employ newer and/or more efficient technologies (e.g. just-in-time inventory management). These externalities operate outside of the market and are not reflected in market pricing, so they are not taken into account by market actors. This theory is supported by a number of empirical papers’ findings that the output contribution of infrastructure is greater than that of conventional capital.

The empirical literature has various divisions, but most studies conclude that there is a significant positive effect of infrastructure on output, productivity, and long-term growth rates. In the late 1980’s, Aschauer produced a series of papers on the relationship between infrastructure and productivity, which sparked a flurry of follow up papers on the subject. His work garnered much attention due to the shockingly high rates of return found on public infrastructure. Since, much more research has been produced, refining the estimation techniques to get results that are within the normal range of experience.

Specifically, an approach guided by Hulten and Schwab (1984, 1991, and 2000) focuses on total factor productivity as opposed to real output for the left-hand side variable, thus reducing the dependence of model results on econometric specification and also reducing the problem of reverse causality. Importantly, this approach allows one to isolate the positive externalities of infrastructure investment and their effects on industry-specific productivity. Bom and Ligthart (2009) report that a mid-point estimate from recent studies of the elasticity of GDP with respect to infrastructure is approximately 0.15 for developed economies.

These papers fall within the realm of the growth accounting literature. Growth accounting provides a way to determine the amount of growth over a period of time due to changes in certain factors of production. The three factors modelled are labour, capital, and the residual, TFP. Easterly and Levine (2001) found that large differences in TFP made up a large portion of the difference in income per capita across countries (both the level and the growth rate of income per capita). For OECD countries, they write that the component of GDP growth attributed to TFP growth is approximately 50%. As long as sub-optimal levels of investment in infrastructure in an economy are tolerated, growth will necessarily be constrained due to lower TFP growth.

3 Estimating the Impact of Air Transport on Productivity Econometrically

The previous section discussed the various channels through which improvements in air transport services provides wider-benefits to the economy. Arguably the most important way in which these "catalytic" benefits result in a sustained long-term benefit to the economy is insofar as they result in an increase in the economy's productivity.

This section describes OE's econometric model ("connectivity model") that quantifies the contribution that air transport services makes towards explaining the long-term productivity performance of the UK economy.

Key points

- Based on an econometric model, we estimate that a 10 per cent increase in business related connectivity increases economy-wide productivity – and hence GDP - by 0.5 per cent in the long-run. In terms of today's GDP this benefit is equivalent to £6.9 billion.
- Business-related connectivity is measured using Oxford Economics' business connectivity metric, described in Section [2.2.2]. The measure, which covers both business-related travel and freight, is designed to focus on the linkage between the provision of air transport services and long-run productivity growth.
- The economic benefits are measured in terms of Total Factor Productivity (TFP). Gains in TFP capture many of the wider economic benefits that are often overlooked (or at least not quantified) in traditional transport appraisals. These benefits include the dynamic gains generated by the quick adoption of new ideas –such as inventions and new business methods – and from the ready access to new and fast growing overseas markets.
- To estimate the TFP gains, we model the linkage between TFP performance and air transport usage of 31 industry and service sectors over a 30 year period (1980 to 2010). The model – which builds on research published in 2006 –has been re-estimated and tested using the most up to date data available. Our findings are consistent with the results published in 2006.

OE's econometric model is described at length in our 2006 study of the importance of the Aviation sector to the UK economy.[12]

The model's structure is summarised below.

- The model looks at the relationship between the use of air transport services and productivity performance at a detailed industry level.
- Uses a 'panel' of data for 31 UK industry and service sectors spanning 30 years (1980 to 2010).
- Productivity is measured by total factor productivity (TFP), the efficiency which output is produced allowing for both labour and capital inputs. By taking account of capital inputs, TFP provides a better measure of efficiency than labour productivity (output divided by employment) when modelling a number of industries which differ in their capital intensity.

[12] The Economic Contribution of the Aviation Industry in the UK, 2006, Oxford Economic Forecasting

- The model takes account of other influences on sector-level TFP through including sector-specific time trends and constants. The impact of air transport services is estimated as varying proportionately with how important air transport services are within the purchased inputs made by each industry.
- OE's connectivity model measures the air transport services by OE's business connectivity metric. As described in Section 2, this measure focuses on business passenger numbers and freight tonnage, since these are the services that are likely to affect the efficiency of business operations. In the model, the connectivity metric is divided by GDP, to provide an indicator of the aviation-intensity of the economy.
- The final model links TFP in each industry to an industry constant, an industry time trend and business air transport services use relative to GDP, weighted by the importance of air transport services in the industry's costs.
- The 2006 model implies that, other things equal, a 10 per cent increase in business air usage raises GDP by 0.6 per cent. (We will revisit this estimate below.)
- To try and get as much information as possible to base the estimates on, data from across 31 different industrial and service sectors are pooled. This is more "efficient" in an econometric sense than just using data on the economy as a whole, since it allows the estimated effects to be based on a much richer pool of information while common coefficients can still be imposed where appropriate across sectors.

3.1 Other Closely-Related Research

A number of other studies have examined the long-run relationship between the output of the aviation sector and the long-term productivity performance of the wider economy.

In 1999, a study by OE reported a loose consensus at the time that a 10 per cent increase in transport services would increase the economy-wide TFP by between 0.5 and 4.0 per cent.[13]

In 2005, OE examined the relationship between economy-wide TFP and the business sector's use of air transport services across 24 European countries.[14] Using a cross-country panel approach over a ten year period, the research used OE's business connectivity metric to measure the business sector's use of air transport services. The study found that in the long-run, a 10 per cent increase in output of air transport services would increase productivity and output by 0.56 per cent.

In 2006, research that used IATA's connectivity index (see Section 2) to study the link between economy-wide and the air transport services reached similar conclusions.[15] The model found that a 10 per cent increase in connectivity (relative to GDP) increases productivity and GDP by 0.9 per cent in the long-run.

[13] Ref 1999 report

[14] The Economic Catalytic Effects of Air Transport in Europe, 2005, Oxford Economic Forecasting

[15] Airline Network Benefits: measuring the additional benefits generated by airline networks for economic development, 2006, Intervistas.

3.2 Updating Oxford Economics' Connectivity Model

We have revisited the econometric analysis underlying the 2006 connectivity model. By doing so we are able to take advantage of:

- several more years of data (2006 to 2010) to bring the analysis up to date and help refine our estimates. The need for refreshing the evidence base on which the model is estimated seems especially pressing given the change in the economic landscape since 2005;
- recent advances in the measurement of productivity performance for over 30 industrial and service sectors. Advances in methodology in recent years has transformed the state-of-the art in this field of economic statistics and it is important to test the model against the new data to ensure that the estimates reported in 2006 prove robust to our new understanding of the economy's productivity performance over recent decades; and
- to use this extra "length and breadth" of data to provide a refined central estimate for the impact elasticity together with an upper and lower estimates that provide an indication of the "precision" of our central estimate.

The original model was estimated using data on the productivity performance of over 30 industrial and service sectors, based on statistics from the OECD. In recent years, a "new generation" of productivity statistics have been released. This new data – known as KLEMS (for Capital, Labour, Energy, Materials, and Services) - reflects advances in methodology and the commitment by statistical agencies to provide the necessary funding. Fortuitously, the industries covered by KLEMS are a very similar to those used in the 2006 study. Moreover, the KLEMS data covers the whole period from 1980 to 2010.

The impact elasticity reported in 2006 was based on the following econometric model:

$$\log TFP_{i,t} = \alpha_i + \beta_i Time_{i,t} + \vartheta \times [\omega_i \times (busair_t / GDP_t)]$$

Where $TFP_{i,t}$ denotes Total Factor Productivity in sector *i* and year *t*; α_i and $Time_t$ control for differences in the initial level and the growth rate of technical progress across the 31 industry and service sectors; $busair_t$ and GDP_t denote OE's connectivity metric, and UK economic output (Gross Domestic Product), respectively; ω_i denotes spending on air transport services per employee, measured relative to overall average spend across all 31 sectors – this is used to take account of the fact that the sectors most likely to benefit from improved air connectivity are the sectors which make the most use of air transport; and finally, ϑ measures the impact that a change in air connectivity has on sector-level productivity. The long-run impact elasticity – which measures the percentage change in TFP (and hence GDP) for a one per cent change in air connectivity (measured relative to GDP) – is calculated by multiplying the coefficient ϑ by the average value of $\omega_i \times (busair_t / GDP_t)$ measured over all sectors.

The model is structured as a "pooled" regression that through its:

- *time-series dimension* captures the long-term relationship between productivity performance and the adequacy of the country's air transport infrastructure - dividing air connectivity by GDP picks up whether air transport services are keeping pace with the growth of the economy; and
- *cross-section dimension* (the 31 industry and service sectors) makes full use of the different intensity which the sectors use air transport to detect the contribution that air transport makes to their relative productivity performance.

3.3 Results

The 2006 report provides an exhaustive description of the model together with the statistical tests which were undertaken during the modelling work (Annex B of the 2006 report). We performed a similar set of statistical tests when re-estimating the model using the KLEMS productivity data. As the test results were very similar to those reported in 2006, we refer the interested reader to the 2006 report for a thorough discussion of the procedures followed. Our main findings are:

- The use of KLEMS productivity data does not change the model results significantly. There is some reduction in the central estimate for the elasticity (see below), but magnitude of the elasticity is in the same ball park and most importantly it remains statistically significant – in other words, as in 2006 we find strong evidence that an industry's use of air transport services has an appreciable impact on its long-term productivity performance.
- There is some evidence that the magnitude of the elasticity has increased since the 1980s. Shortening the time period over which the model is estimated, to exclude all or part of the 1980s increases the impact. However, we would suggest caution in placing too much emphasis on this finding, as shortening the time-series dimension entails a substantial reduction in the number of data points which the model needs to "gain traction".
- In addition to (1) estimating the model on the original OECD and the new KLEMS productivity data, and (2) exploring different time frames, we also revisited the dynamic structure of the model to see how the model performed with the KLEMS data. Our tests, which naturally caused some variation in the elasticity but did not change our key findings – justifies reporting the new refined central estimate for the impact elasticity alongside a lower and upper range that conveys the sensitivity of the elasticity to the range of choices one may reasonably make regarding data and model specification.
- Our central estimate for the long-run elasticity is 0.05, slightly lower than the 0.06 reported in 2006, and reflects the tests we performed on model- and data-robustness described above.
- Our estimate is the central (as in the average or most likely) value among a range of plausible values. Our analysis suggests that the range of plausible values fall within the range 0.03 to 0.08. Based on our robustness tests, this range also matches well with the range of values reported in other research.

3.4 Quantifying the Economic Impact of Airport Development

Using our central estimate for the impact elasticity, the long-term economic benefit of expanding airport capacity in the London area is equivalent to £6.9 billion a year (at today's prices). Our range of plausible values for the elasticity provides a lower and upper value for the GDP impact of £4.2 billion and £11.1 billion respectively.

These estimates are based on comparing the Department for Transport's (DfT) forecasts for air transport services based on (1) assumption that capacity will remain constrained over the next 35 years, with (2) a forecast of demand unconstrained by airport capacity. In terms of total passenger numbers the two forecasts differ by around 35 million passengers by 2050, an increase which the various options for airport expansion are all designed to meet. Our model measures the connectivity in terms of benefits generated from an increase in business passengers and freight. In terms of the increase in business use of air transport services between the constrained and unconstrained forecasts (by 2050), the DfT forecast a 3 mppa increase in business passengers, while analysis presented in the technical note dealing with impacts on the air freight industry argues that freight is likely to increase by just over 1 million tonnes. Together they represent a 9%

increase in business usage (as measured by OE's connectivity metric). Using the central estimate for the elasticity (0.05), gives a benefit equivalent to 0.45% of GDP. In terms of today's GDP (£1,540 billion), this is equivalent to an annual benefit to the economy of £6.9 billion.

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